

# Astrophycology

& the Development of Biological Experiments  
for Nanosatellites and Lunar Rovers

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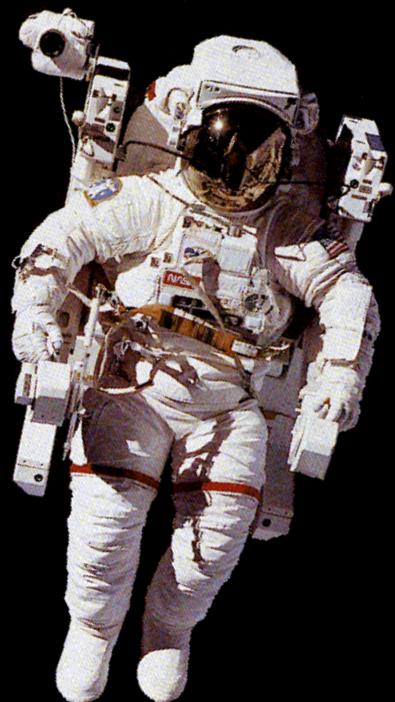
**Alexis Crane**

**Leona Wong**

# A Space Travel Dilemma



# What Astronauts Want...



CO<sub>2</sub>  
O<sub>2</sub>  
Food  
Waste

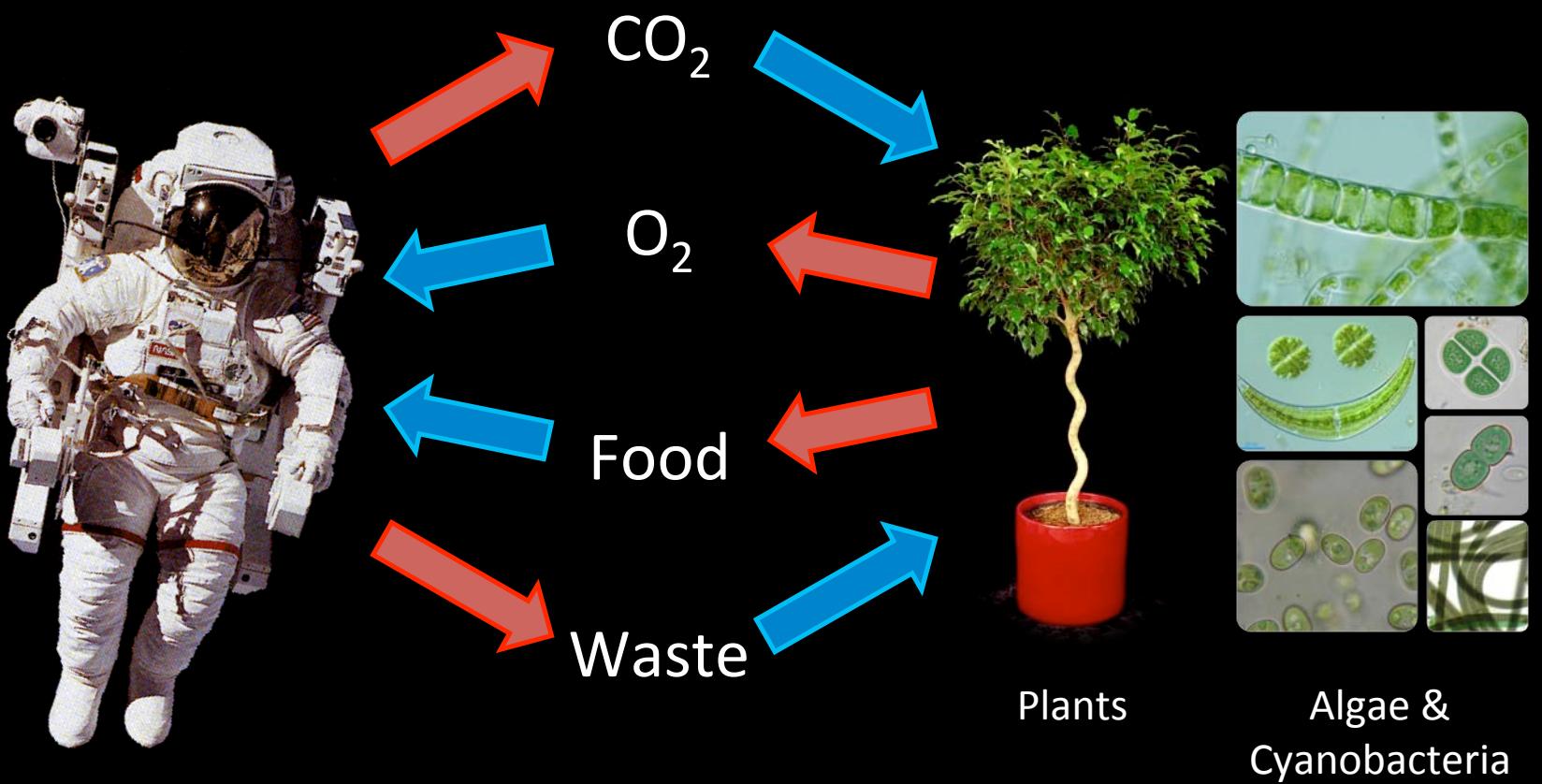


CDRA CO<sub>2</sub> Scrubber

Elektron O<sub>2</sub> Generator

Water Reclamation System

# A Case for Photosynthesis



# A Case for Photosynthesis Cont.

Potential:

Life Support ( $O_2$ , food, water reclamation, waste processing)

*In Situ* Resource Utilization ( $CH_4$ ,  $H_2$ , shielding)

Regenerative

Space Stress:

Microgravity

Cosmic radiation

Substrate (regolith)

Compound effects

Evolution



# Using Nanosats for Photosynthesis Studies

Cheap

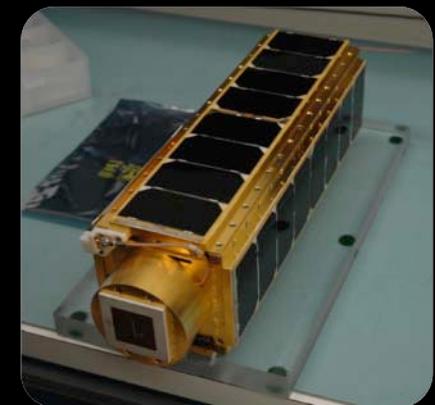
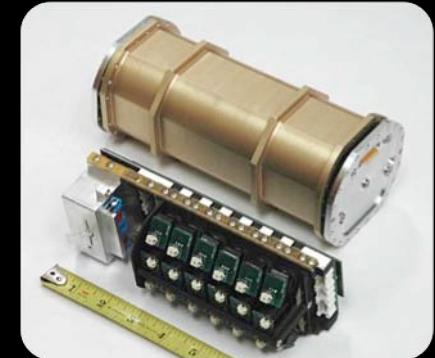
Autonomous microlaboratories

High replication (48+ wells of biology)

Multiple organisms

Gravisat – Various degrees of microgravity

AlgaeSat – Radiation and microgravity



**GRAVISat**

**ALGAE**Sat  
A Space Laboratory for Investigations of Microbial Ecology

# GraviSat

**Specifications:**  
Spinning Disc – 0-1 g

**Sensor Suite:**

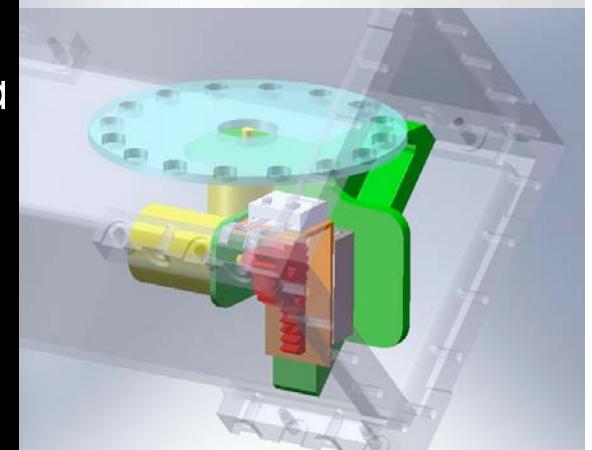
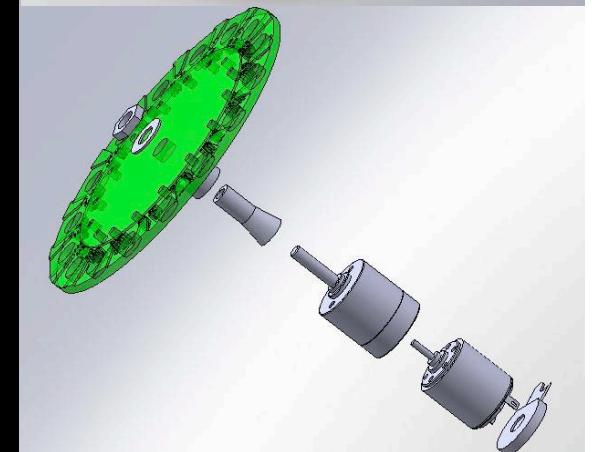
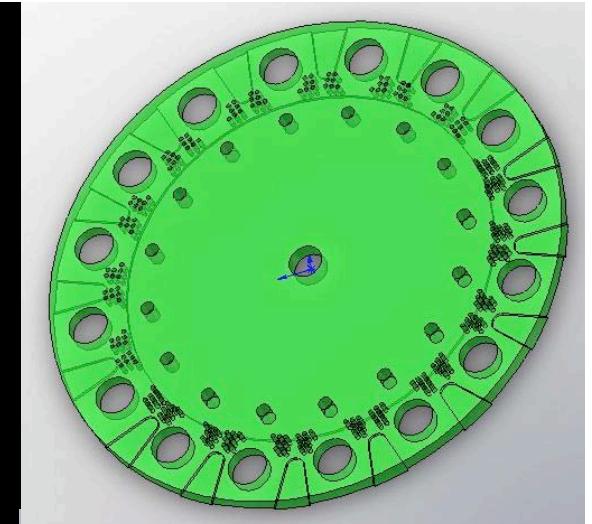
Optical Density	→ Growth
Oxygen	→ Photosynthesis/Respiration
pH	→ Metabolism
PAM Fluorometry	→ Photosynthesis

Real-time measurements

Microfluidics – limited medium transfer

**In Process:**

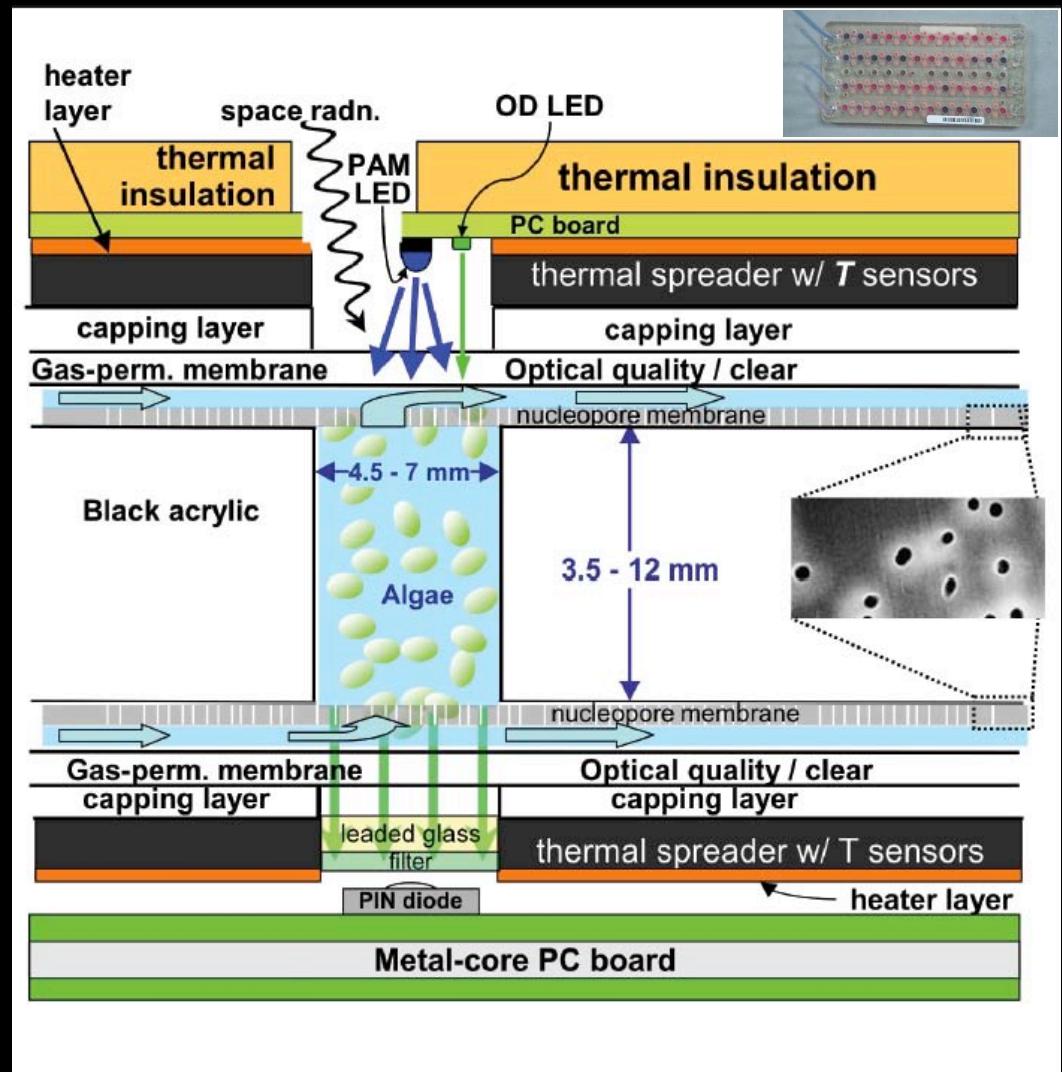
- 1) Biocompatibility – Algae and cyanobacteria
- 2) Miniaturizing sensors
- 3) Adapting algae to GeneSat/PharmaSat technology
- 4) Stasis



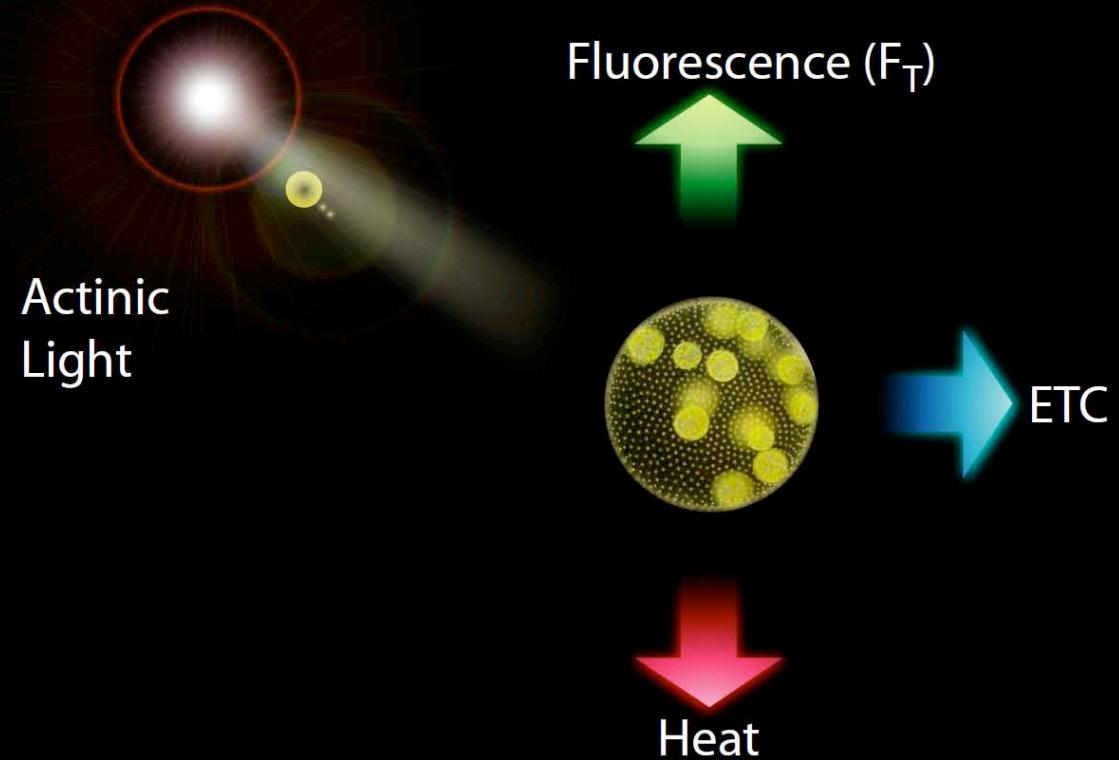
# Pulse Amplitude Modulated (PAM) Fluorometry



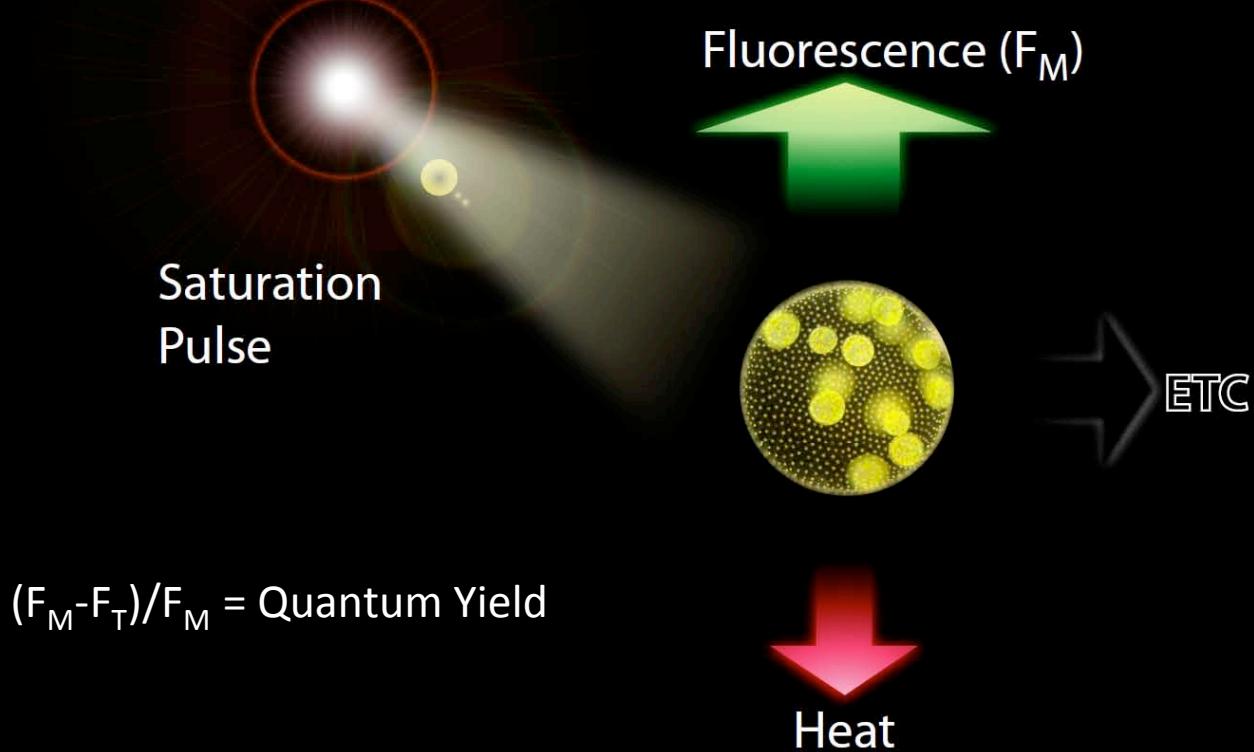
# Space PAM Fluorometer Prototype (Walz GMBH)



# PAM Fluorometry

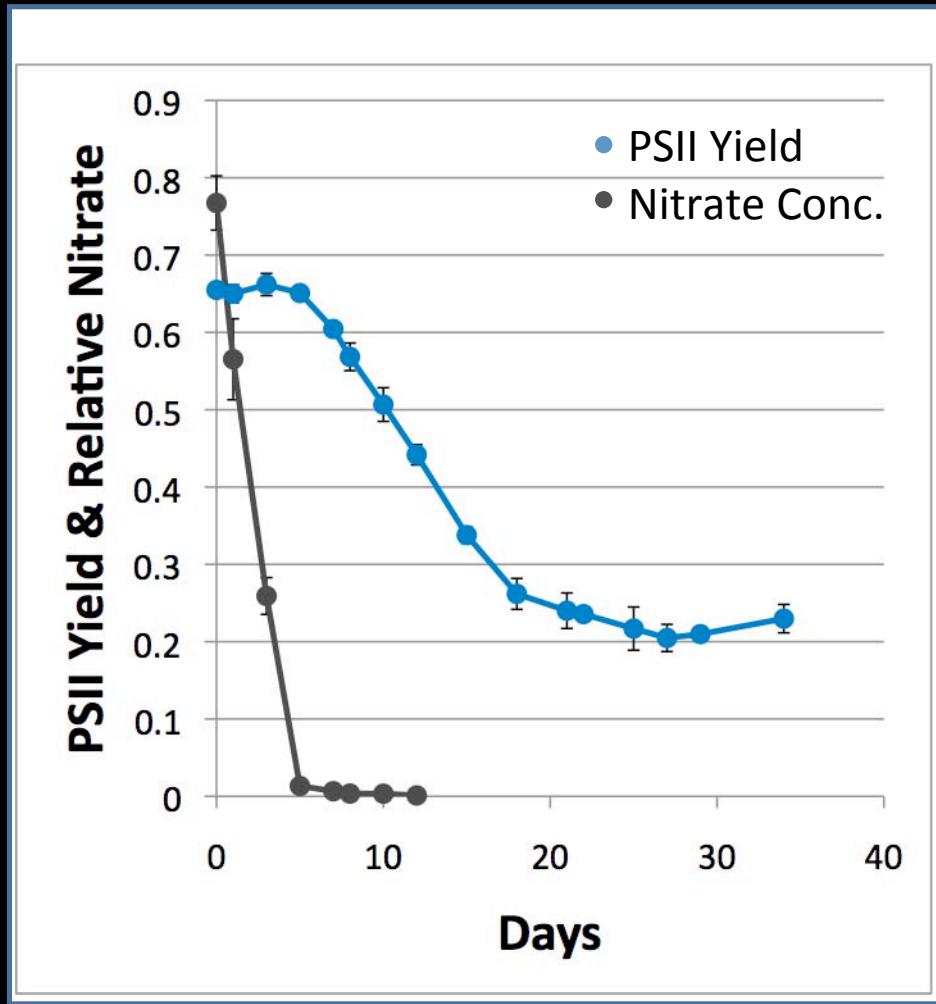


# PAM Fluorometry

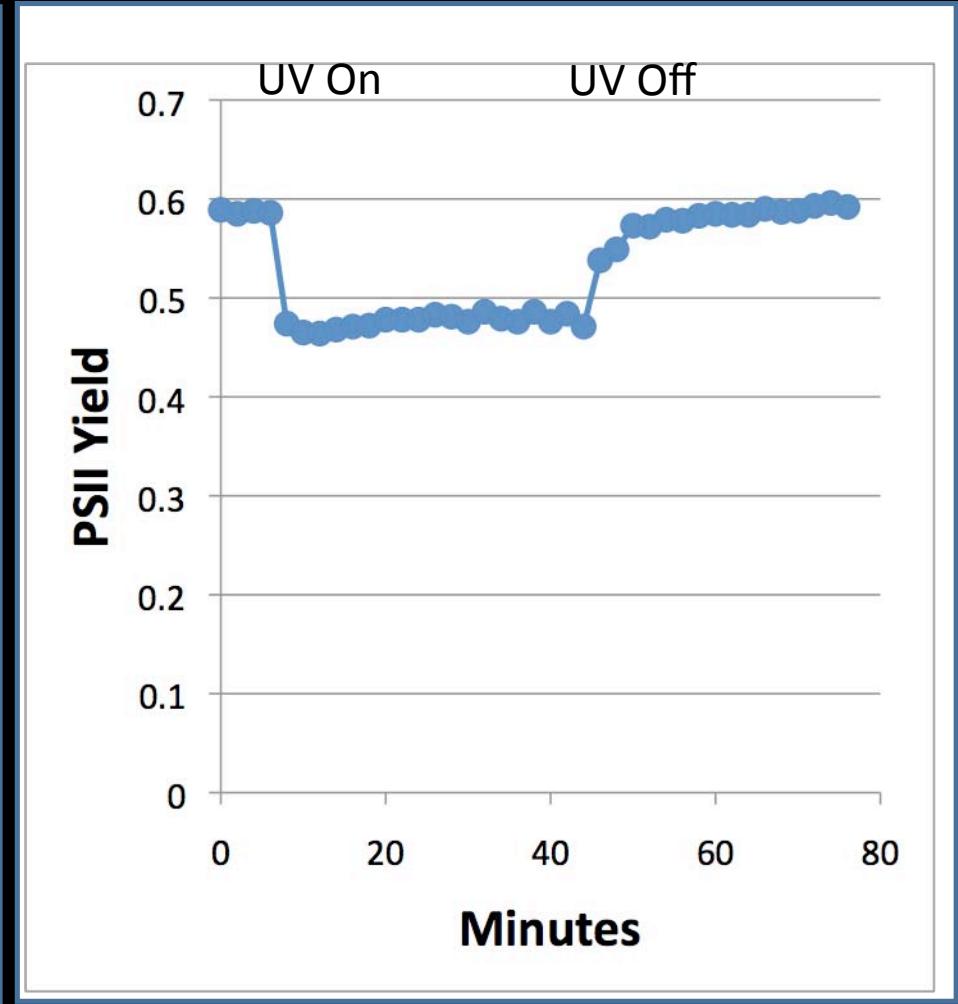


# PAM Fluorometry and Stress

*Scenedesmus*



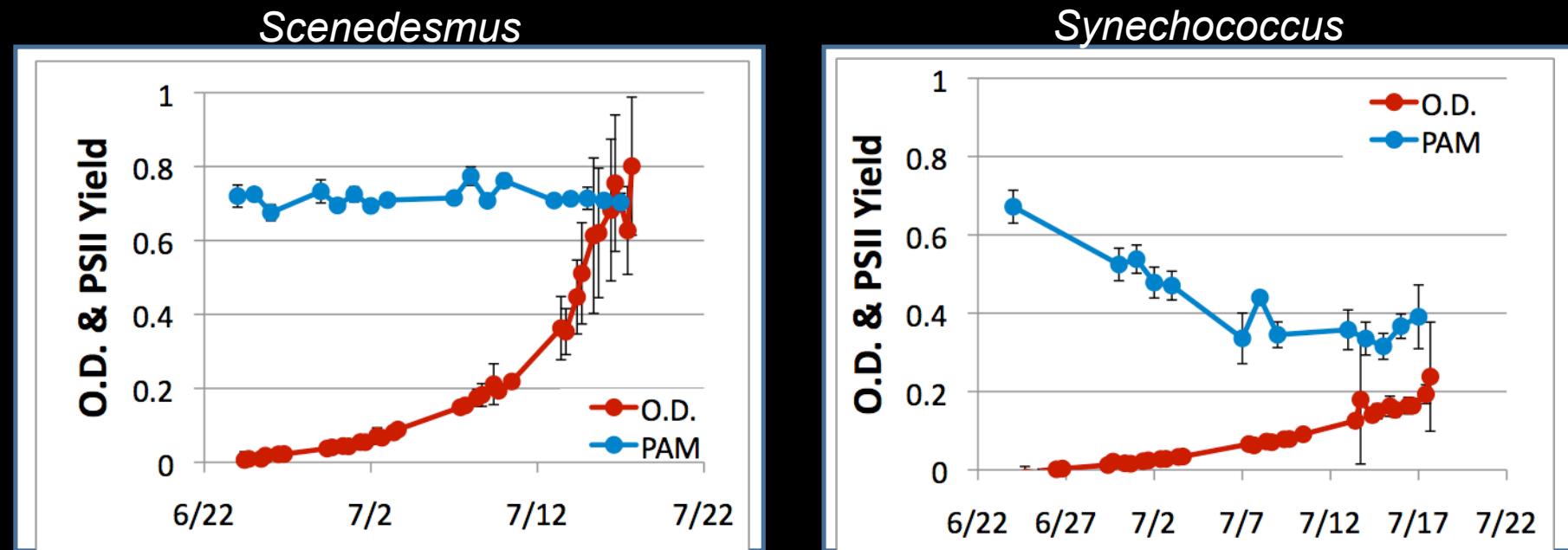
*Scenedesmus*



# Adapting Algae to Nanosatellites

- Biocompatibility
- 6 month mission duration
- 2-4 week stasis period
- Maintain optical environment in wells

# Adapting Algae to Nanosatellites (Mission Duration)

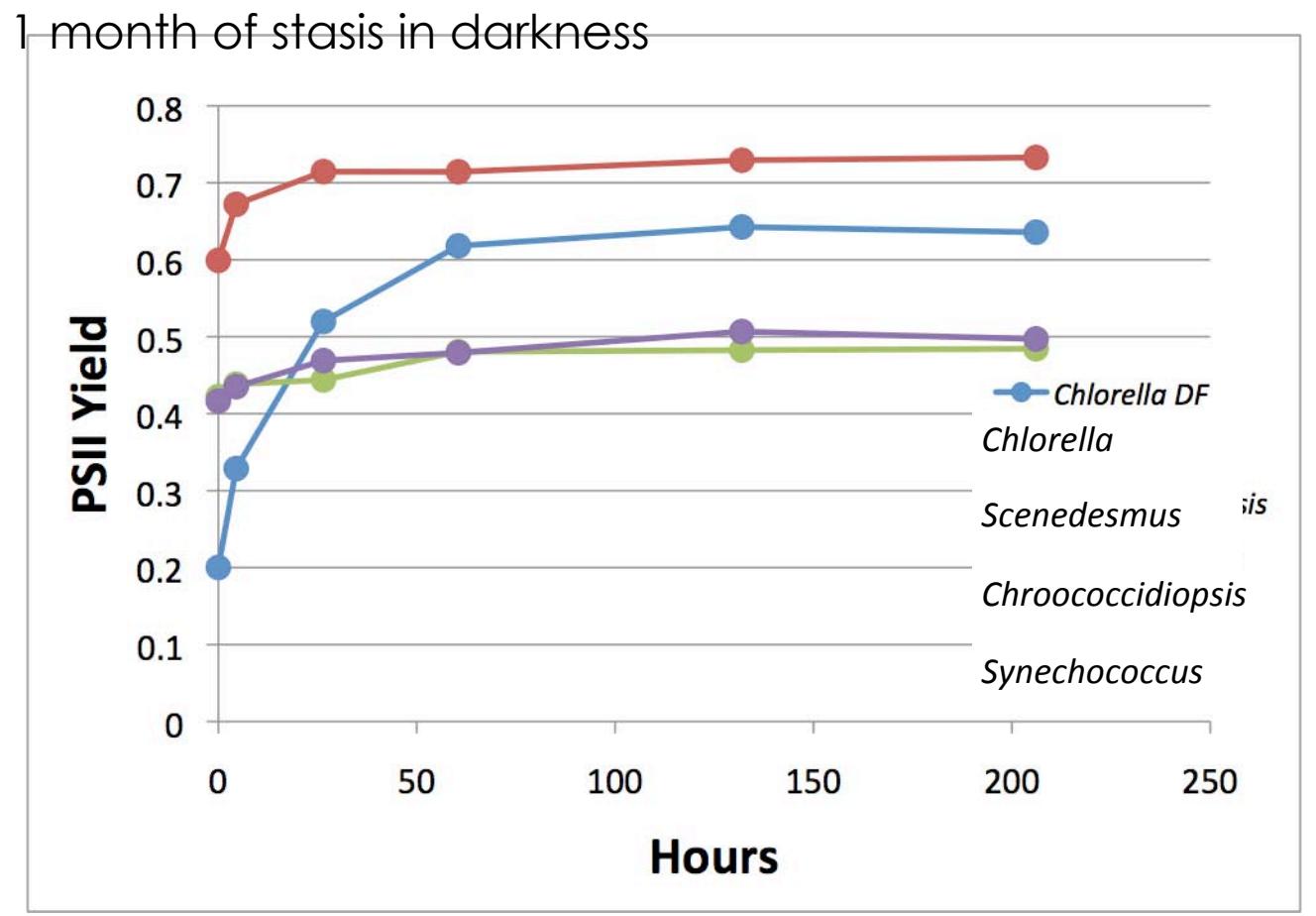


Screening algae and cyanobacteria for suitable strains

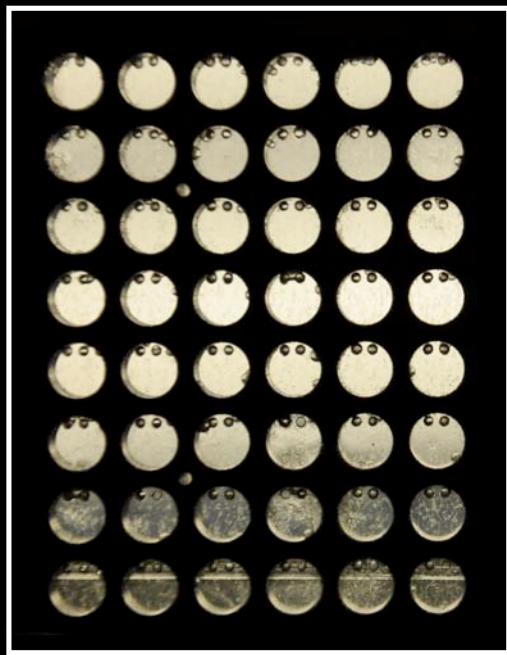
Manipulating: Light intensity, Light/Dark cycles, Temperature, Nutrients

Slowing growth to extend mission length (6 months)

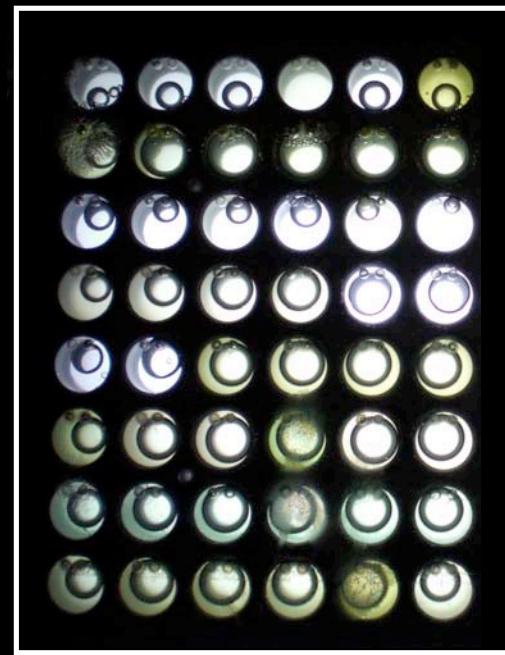
# Adapting Algae to Nanosatellites (Stasis)



# Adapting Algae to Nanosatellites (Bubbles)



Two Weeks



## Interference:

Optical measurements (O.D.)  
Microfluidics

## Solutions:

Environmental manipulation  
Physical removal



Questions